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(54) Title of the Invention   Polishing Device

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Specifications

1. Title of the invention   Polishing Device
2. Claims
   1. A polishing device comprised of an index table installed to rotate freely around a center axis;
      a plurality of intermediate tables installed to rotate freely on the index table positioned around the index table;
      at least one chuck table installed to rotate freely on the intermediate tables that can secure the product on the surface;
      a plurality of operating areas including at least two polishing areas placed in specific positions around the index table;
      a polishing means positioned on each of the polishing areas to polish the surface of the product;
      an index means for sequential positioning of at least two operating areas including at least two polishing areas of the plurality of operating areas on the intermediate table that rotates intermittently around the index table;
      and a rotation means that rotates the intermediate table for rotation of the chuck table.
   2. A polishing device as claimed in Claim 1 where the plurality of intermediate tables are installed on the index table and

placed at multiple positions around the circumference of the index table where the radial distance from the center axis of the index table is identical.

3. A polishing device as claimed in Claim 2 where there

are a plurality of operating areas placed at multiple positions around the circumference of the index table where the radial distance from the center axis of the index table and intermediate table is identical.

4. A polishing device as claimed in Claim 3 where the number of intermediate tables and the number of operating areas are identical and the index means intermittently rotates the index table at an angle between the adjacent intermediate tables and each of the intermediate tables have a plurality of operating areas arranged in sequence.
5. A polishing device as claimed in any of Claims 1-4 where there is a plurality of chuck tables installed on each of the intermediate tables.
6. A polishing device as claimed in Claim 5 where each of the plurality of chuck tables are installed on the intermediate tables at multiple positions around the circumference of the index table and are all positioned so the radial distance from the center axis of the intermediate tables is identical.
7. A polishing device as claimed in any of Claims 1-6 where the plurality of operating areas include an area for removal and loading of the product, a plurality of polishing areas and a plurality of washing areas positioned between the plurality of polishing areas;
   where the intermediate table first has a product removal and loading area, then an initial polishing area, followed by a washing area before the next polishing area, and then back to the product removal and loading area after the final polishing area.
8. A polishing device as claimed in Claim 7 where each of the washing areas are equipped with a washing liquid spray means that sprays the washing liquid on the product positioned on the chuck tables.
9. A polishing device as claimed in Claim 7 or Claim 8 where the plurality of polishing means placed in a plurality of polishing areas sequentially conducts high precision polishing on the surface of the products positioned on the chuck tables.
10. A polishing device as claimed in any of Claims 1-9 where the rotation means is comprised of first transmission means connected to the polishing areas and second transmission means installed on each of the intermediate tables, and where when each of the intermediate tables is positioned at a

polishing area, the first transmission means drives the connected second transmission means.

11. A polishing device as claimed in Claim 10 where the rotation means contains a driver connecting each of the polishing areas to the first transmission means.
12. A polishing device as claimed in Claim 10 or Claim 11 where each of the first transmission means has an output element selectively installed with an operational position and a non-operational position, and when each of the intermediate tables are positioned in a polishing area, the output element engages the input element of the second transmission means at the operational position and the first transmission means drives the second transmission means.
13. A polishing device as claimed in Claim 12 where the output element is an output gear and the input element is an input gear, and when the output gear moves in the direction of the input gear around its central axis, it moves from the non-operational position to the operational position so the teeth of the output gear and the teeth of the input gear form a lap around the tip of the teeth as they come into contact.

Detailed Description of this Invention

[Industrial Field of Application]

This invention relates to a polishing device that polishes and laps the surface of a semiconductor wafer but is not limited to such. The phrase "polish" used in these specifications refers to polishing and lapping.

[Existing Art]

Production of semiconductor devices generally requires thin semiconductor wafers as well as a smooth mirror surface, thus polishing of the semiconductor wafer surface is essential. When actually polishing the semiconductor wafer surface, various forms of polishing devices have been utilized (For an example, refer to the specifications and figures of US Patent 4,141,180).

Existing polishing devices and polishing systems have the following problems or issues. (1) Multiple large parts; (2) Relatively low level of polishing efficiency; (3) Polishing devices with multiple separate parts with varying levels of polishing amount and polishing accuracy, where the semiconductor wafers are sequentially supplied to the multiple polishing devices so highly accurate polishing of the semiconductor wafer does not occur, the production cost is high and the manufacturing efficiency is low; (4) Complete automation of the polishing process is not possible.

[Objective of this Invention]

The main objective of this invention is to present an excellent polishing device that is relatively simple and compact that can sequentially perform various types of polishing with varying levels of polishing quantities and polishing accuracy on products, specifically semiconductor wafers with high levels of operating efficiency.

Another objective of this invention is to provide a polishing device capable of relatively simple automated polishing.

[Summary of this Invention]

This invention is for a polishing device comprised of an index table installed to rotate freely around a center axis, a plurality of intermediate tables installed to rotate freely on the index table positioned around the index table, at least one chuck table installed to rotate freely on the intermediate tables and that can secure the product on the surface, a plurality of operating areas including at least two polishing areas placed in specific positions around the index table, a polishing means positioned on each of the polishing areas to polish the surface of the product, an index means for sequential positioning of at least two operating areas including at least two polishing areas of the plurality of operating areas on the intermediate table that rotates intermittently around the index table, and a rotation means that rotates the intermediate table for rotation of the chuck table.

[Embodiment Examples of this Invention]

Next is a detailed description of specific examples of the polishing device in this invention, using the attached figures as references.

Summary of the Overall Structure

To describe the overall structure for the polishing device shown in Figure 1, the polishing device has a central axis 2 around which free rotation is possible (in a direction perpendicular to the paper in Figure 1), with a relatively large disk shaped index table 4. There are multiple disk shaped intermediate tables 6, in the example shown in the figure there are 6, installed on this index table 4 capable of free rotation.

These intermediate tables 6 are placed at multiple positions around the circumference of the index table 4 such that the radial distance from the center axis is identical (positioned at the same angle). There are at least one, ideally a plurality of relatively small disk shaped chuck tables 8 on the intermediate tables 6, and in the example shown in the figure, there are 3 that are capable of free rotation. These chuck tables 8 are placed at multiple positions in a direction perpendicular to the paper in Figure 1 around the circumference of the intermediate table 6 such that the radial distance from the center axis is identical (positioned at the same angle).

There are operating areas placed in a plurality of positions around the circumference of the index table 4. In the example shown in the figure, there are 6 operating areas A, B, C, D, E and F, that correspond to each of the intermediate tables 6. These 6 operating areas A, B, C, D, E and F are placed at multiple positions around the circumference of the index table 4 and around the intermediate table 6 such that the radial distance from the center axis 2 is identical (positioned at the same angle). There is a fixed partition 11 around each operating area A, B, C, D, E and F. Operating area A is the product removal and loading area; operating area B is the rough polishing area; operating area C is the washing area; operating area D is the intermediate polishing area; operating area E is the washing area; and operating area F is the finishing polishing area. There are polishing means for polishing the product surface installed in the intermediate polishing area D and finishing polishing area F (the polishing means will be described later). There are washing liquid spray means installed in the washing areas C and E (the washing liquid spray means will be described later).

With the polishing device described above, the index table 4 rotates intermittently in the direction of arrow 12 at a 60° angle between the intermediate tables 6, sequentially through the product removal and loading area A, the rough polishing area B, the washing area C, the intermediate polishing area D, the washing area E and the finishing polishing area F of the intermediate tables 6. The product removal and loading area A includes a standard removal means (not shown in the figures) that removes the semiconductor wafer for polishing from the chuck table 8. The products removed are separately loaded to the final washing area (not shown in the figures). Purification is conducted in the final washing area using a liquid spray and then they are transported to the holding area or directly to the next processing device. After product removal, the semiconductor wafer product is loaded using a standard loading means (not shown in the figures) on the chuck table 8 with the surface to be polished face up. The product loaded on the chuck table 8 is

adequately secured using vacuum adhesion. At the rough polishing area B, the intermediate table 6 rotates in the direction shown by arrow 14 and the chuck table 8 and the product placed on the top rotate while the chuck tables 8 rotate in the direction shown by arrow 16. Therefore, the rotation direction of the intermediate table 6 is opposite that of the chuck table 8 and the product placed on the top.

The polishing means works on the surface of the product to roughly polish the surface at a relatively high polishing volume. In the washing area C, washing is conducted by spraying wash liquid on the product on the chuck table 8 using the washing spray means. The intermediate polishing area D is where the surface of the product is subject to intermediate polishing on an intermediate volume in the same manner as conducted in the rough polishing area B. Washing similar to that conducted at the washing area C is conducted on the product at washing area E. Polishing similar to that conducted at the rough polishing area B is conducted on the surface of the product at the finishing polishing area F, but on a relatively small polishing volume at high levels of accuracy.

With the example shown in the figures, there are 6 operating areas A, B, C, D, E and F corresponding to the six intermediate tables 6. Each of the intermediate tables 6 correspond to the operating areas A, B, C, D, E and F due to the rotation of the index table 4. If applicable, there can be 12 intermediate tables on the index table with two each of the operating areas A, B, C, D, E and F, for a total of 12 operating areas. Each of six intermediate tables can correspond to a sequence of a group of operating areas A, B, C, D, E and F while the remaining 6 intermediate tables can correspond to a sequence of another group of operating areas A, B, C, D, E and F. There are multiple intermediate tables in two concentric circles arranged on the index table and there are multiple operating areas in two concentric circles corresponding to these. Each of these inside intermediate tables are positioned sequentially with the inside operating areas. Each of these outside intermediate tables are positioned sequentially with the outside operating areas.

Index, Intermediate and Chuck Tables

Next is a description of the index table 4, the intermediate tables 6 and the chuck tables 8 using Figure 1 and Figure 2 as references.

The polishing device in the figures has a main support axis (not shown in the figures) perpendicular to the central axis 2 of the index table 4 (Figure 1). The index table 4 is set to rotate freely around this main support axis. There is a fixed circular support table 18 underneath the index table 4 and there is a round guide rail 22 for the round guide 20 formed underneath the index table 4 on this support table 18. The index table 4 is completely supported by the support table 18 in a horizontal position. On the side of the support 18 there is an L-shaped channel 24 that acts as a drainage channel. The index table 4 is connected to a driver 26 such as an electric motor via conductive wiring (not shown in the figures). This driver

26 is constructed of an index means to intermittently rotate the index table 4 at particular intervals at a 60 degree angle.

As shown in Figure 2, the method of attaching the intermediate tables 6 on the index table 4 and the method of attaching the chuck tables 8 on the intermediate tables is as follows. There is a rotation axle 28 extending through the index table 4 at a right angle (in Figure 2 only one rotation axle 28 is shown) for each of the six intermediate table attach positions for the index table 4 with radial bearings 30 and thrust bearings 32 and 34 attached for free rotation. These are installed under the intermediate table 6 on the top of each rotation axle 28.

There is a round part 36 affixed to the bottom side of the intermediate table 6. There are multiple short axes 38 protruding to the outside in the radial direction around the circumference of this round part 36. There are freely rotating guide rollers 40 installed on the tips protruding from each of these short axes 38. There are round guide rails 42 formed to correspond with each of the intermediate tables 6 on the top of the index table 4. Each of these guide rollers 40 rides on the top of the round guide rails 42. The bottom side of the intermediate table 6 is supported by the circular guide rail 42 via the guide roller 40. Thus the intermediate table 6 is supported in a completely horizontal position. There are vertical openings 44 on each of the three chuck table positions for attachment on each of the intermediate tables 6. The chuck tables 8 are installed such that there is free rotation due to the radial and thrust bearings on each of the openings 44 (only 2 openings 44 and 2 chuck tables 8 are shown in Figure 2). Each of the chuck tables 8 in the figures is constructed of an upper part 48 that protrudes from the top of the intermediate table 6 and a bottom part 50 affixed on the bottom of the top part 48. There is a protective cover 52 on each of the chuck tables 8 as well as protective covers 54 and 56 on each of the intermediate tables 6. These protective covers 52, 54, 56 prevent the polishing slurry used in the polishing areas B, D and F (Figure 1) and the washing liquids used in the washing areas C and E (Figure 1) from being introduced into the support structure of the chuck table 8 and intermediate table 6.

The following flow channel means exists on each of the intermediate tables 6 and chuck tables 8 of the polishing device in the figures. The description continues by referencing Figure 2. There are multiple continuous flow channels 58 extending vertically in the center of the upper part 48 of the chuck tables 8. There are multiple radial channels 60 extending from the outside of the continuous channels 58 and multiple reserve channels 62 extending from each of the radial channels 60 to the top of the upper part 48, spaced in radial directions. The outside of each radial channel 60 is sealed using standard methods. There is a relatively shallow round recessed part 64 formed in the top of the bottom part 50 on the chuck tables 8. There are round recessed parts 64 on the bottom tips of each of the continuous channels 58. A round groove 66 is formed around the bottom outside edge of the bottom part 50. The round groove 66 and the round recessed parts 64 fit together to form the flow channel 68. The round groove 66 formed on the bottom part 50 surrounds the round manifold 70 that does not move in conjunction with the intermediate table 6. There is a sealed space 72 between the rotation axle 28 and the intermediate table 6 on the top. There is a radial channel 74 extending from this sealed space 72 to the inside of each opening 44

in a radial direction. The outside edge of each of the radial channels 74 is connected to the round manifold 70 by short tubes 76. There is a channel 78 extending from the top of the rotation axle 28 to near the bottom and then around in a radial direction. The bottom edge of the rotation axle 28 is enclosed by the round part 80 that does not move in conjunction with the index table 4. There is a round groove 82 around this round part 80. The flow channel 78 formed on the rotation axle 28

is connected to the round groove 82 and the sealed space 72. There is a radial flow channel 84 extending from the round groove 82 to the outside. This flow channel 84 is connected to a vacuum source 90 by a tube 88 that has a standard switching valve 86 and to a power source 92 for liquids such as water.

When the intermediate table 6 is in position for the product removal and loading area A (Figure 1), the switching valve 86 operates to switch the flow channel means from the vacuum source 90 to the power source 92. Thus, the liquid supplied from the power source 92 flows to the top of the chuck table 8 via the continuous flow channel 58 and the reserve flow channel 62 formed on the upper part 48 of the chuck table 8. The product such as a semiconductor wafer vacuum attached to the top of the chuck tables 8 up to that point is lifted from the top of the chuck table 8. The liquid flowing on the top of the chuck table 8 washes the chuck table 8. The first product is removed from the chuck table 8 and the next product is loaded on the chuck table 8. Then the flow path means operated by the switching valve 86 is connected to the vacuum source 90. Air is suctioned from the continuous flow channel 58 and the reserve flow channel 62 formed on the upper part 48 of the chuck table 8 and the product is vacuum attached to the top of the chuck table 8.

The polishing device in the figures is as shown in Figure 1 where the rough polishing area B, the intermediate polishing area D and the finish polishing area F, rotate with the intermediate tables 6 in the direction shown by arrow 14. Since it is imperative that the chuck tables 8 rotate in the direction shown by arrow 16, there is a rotation means installed. To continue with the description referencing Figure 2, there is a first transmission means 96 (only the output tip is shown in Figure 2) that drives the driver 94 such as an electric motor for the polishing area B, D and F (Figure 1). In Figure 2, only the driver 94 connected to polishing area B and the first transmission means 96 are shown in the figure but polishing areas D and F involve the same driver and first transmission means. If desired, instead of installing three drivers for the three polishing areas B, D and F, one common driver can be installed. The first transmission means 96 has an output axle 98 that can be installed in the position shown by the dotted line or the position shown by the solid line with an operating means (not shown in the figure) such as an electromagnetic solenoid. There is an output gear 100 on the top of this output axle 98.

There are second transmission means installed on each of the intermediate tables 6 as follows. Input gears 106 that can freely rotate are installed via radial bearings 102 and 104 on the bottom of the rotation axle 28. There is a single 2-part gear 116 that has gears 112 and 114 through radial bearings 108, 110 installed on the

top of the rotation axle 28 capable of free rotation. The rotation axle 118 extending in a perpendicular direction to the index table 4 is installed using radial bearings 120 and 122 for free rotation. The rotation axle 124 extending in a perpendicular direction is installed using radial bearings 126, 128 for free rotation. Gear 130 engages the input gear 106 on the bottom of the rotation axle 118.

Gear 132 engages gear 112 on the 2-part gear 116 on the top of the rotation axle 118. Gear 134 engages gear 132 on the top of the rotation axle 124. There is an internal gear 136 on the bottom inside of the round part 36 affixed to the bottom of the intermediate table 6 and this gear 136 engages gear 134. There is a gear 138 on the bottom of the bottom part 50 of each chuck table 8 and gear 138 engages the 2-part gear 116 gear 114.

When the intermediate table 6 is positioned in the polishing area B (or D or F), the output axle 98 from the first transmission means 96 and the output gear 100 fixed to it shifts from the non-operational position shown by the solid line to the operational position shown by the dotted line. The output gear 100 of the first transmission means 96 engages the input gear 106 of the second transmission means so the first transmission means 96 and the second transmission means are powered. Ideally, as shown in Figure 3, the front section of the interlocked part between the teeth of the output gear 100 and the teeth of the input gear 106, specifically the top of the teeth of the output gear 100 and the bottom of the teeth of the input gear 106 as shown by the numerals 140 and 142, are tapered slightly at the tip of the teeth. As a result, when the output gear 100 shifts from the non-operational position to the operational position, the teeth of the output gear 100 and the teeth of the input gear 106 engage smoothly regardless of the angle. As shown in Figure 2 and Figure 3, when the output gear 100 shifts to the operational position shown by the dotted line, the teeth of the output gear 100 and the teeth of the input gear 106 engage at the non-tapered section so by forming the tapered section 140, 142, there is no slippage as the output gear 100 and the input gear 106 engages. When the first transmission means 96 and the second transmission means are powered, the driver 94 engages. Then gear 136 rotates via the input gear 106, gear 130, gear 132 and gear 134 and the intermediate table 6 rotates in the direction shown by the arrow 14 (Figure 1). Each of the chuck tables 8 rotate in the direction shown by the arrow 14 (Figure 1). At the same time, each of the gears 138 rotates via the input gear 106, gear 130, gear 132 and the 2-part gear 116 and the chuck table 8 rotates in the direction shown by the arrow 16 (Figure 1). When polishing is completed in the polishing area B (or D or F), the driver is disengaged and the subsequent output axle 98 and the output gears 100 affixed to it are returned to the non-operational position shown by the solid line from the operational position shown by the dotted line. Then the first transmission means 96 is disconnected from the second transmission means.

Polishing Means and Washing Means

Figure 4 shows the arrangement of polishing areas B, D and F and shows an abbreviated example of a standard polishing means 144. The polishing means 144 shown in the figure includes a suspension rod 146 capable of rising and lowering while freely rotating on a standard support frame (not shown in the figures). At the bottom of this suspension rod 146 is a disk 148 that can rotate together with the rod 146 and can freely incline in any direction relative to the rod 146 via a standard joint mechanism (not shown in the figures). At the bottom of this disk 148 is an abrasive pad 150. It is acceptable to utilize a polishing pad sold under the brand name "SUBA", marketed by the US company Rodel Products Corporation as the abrasive pad 150.

When the intermediate table 6 is positioned at the polishing area B (or D or F), during the time that polishing is conducted, the raising and lowering means (not shown in the figures) such as a hydraulic cylinder structure lowers the suspension rod 146. The disk 148 and the abrasive pad 150 affixed to the bottom of it are lowered from the position shown by the solid line to the position shown by the dotted line. The surface of the product such as semiconductor wafers W secured to the surface of each of the chuck tables 8 are subject to specific pressure by the abrasive pad 150. At the same time, the driver such as an electric motor (not shown in the figures) rotates the suspension rod 146 at a specific speed and the disk 148 and the abrasive pad 150 affixed to the bottom of it are rotated at a specific speed. There is a supply channel (not shown in the figures) created on the abrasive pad 150 from the power supply (not shown in the figures) to the suspension rod 146 and disk 148. An abrasive slurry containing suspended abrasive grains is supplied along this path. During the polishing operation, as shown in Figure 1, the intermediate table 6 rotates in the direction shown by the arrow 14 and each of the chuck tables 8 rotate in the direction shown by the arrow 16. Products W on each of the chuck tables 8 are rotated in the direction of arrow 14 as they revolve in the direction of arrow 16. Thus, the surface of the product W is polished in the required manner.

Figure 5 shows the arrangement of washing areas C and E and shows an abbreviated example of a standard washing means 152. The washing means 152 in the figure includes a spray nozzle means 154 installed to rotate freely around the support frame (not shown in the figures) and a cover 156 that is raised and lowered on the support frame. There are several spray openings 158 at the bottom of the spray nozzle means 154. There is a sponge or sealing 160 of rubber or other flexible material at the bottom of the opening of the cylindrical cover 156.

When the intermediate table 6 is positioned at the washing area C (or E), during the time that washing is conducted, the raising and lowering means (not shown in the figures) lowers the cover 156 from the position shown by the solid line to the position shown by the dotted line and encompasses the intermediate table 6 to prevent the washing liquid from spraying inside. Using a driver such as an electric motor (not shown in the figures), the spray nozzle means 154 is rotated, a washing liquid such as pure water is supplied to the spray nozzle means 154 and then sprayed from the spray openings 158 on to the product W on each of the chuck tables 8. In this manner, the product W is washed as required.

The descriptions above refer to the attached figures to provide details for specific examples of a polishing device as configured for

this invention. However, this invention is not limited to such examples and the scope of this invention is intended to include a variety of alterations and modifications.

4. Brief Description of the Figures

Figure 1 is an abbreviated surface diagram showing a specific example of the polishing device constructed for this invention.

Figure 2 is a sectional cross-section showing the index, intermediate and chuck tables for the polishing device shown in Figure 1.

Figure 3 is side view showing the output gears and the input gears of the rotation means shown in Figure 2.

Figure 4 is an abbreviated side view showing an example of the polishing means utilized in the polishing devise shown in Figure 1.

Figure 5 is an abbreviated side view showing an example of the washing means utilized in the polishing devise shown in Figure 1.

4...index table
6...intermediate table
8...chuck table
26...driver (index means)
94...driver
96...first transmission means
100...output gear
106...input gear
144...polishing means
152...washing means
A...product removal and loading area
B...rough polishing area
C...washing area
D...intermediate polishing area
E...washing area
F...finishing polishing area

Figure 1

第1図

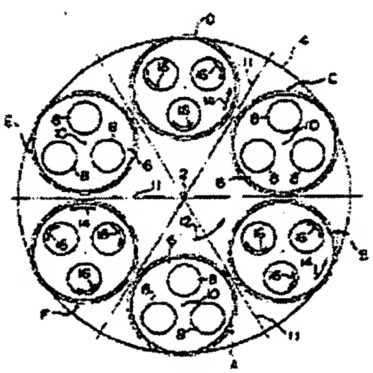
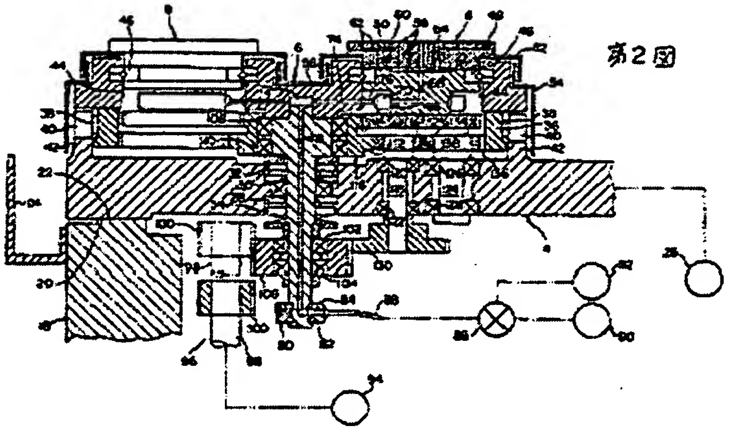


Figure 2



第2図

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Figure 3

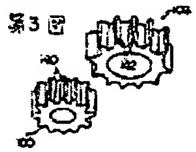

Figure 4

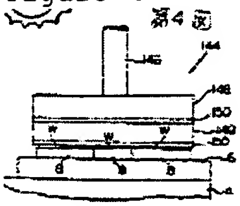

Figure 5